TS 1 – Geospatial Cloud Computing I

High Performance Cloud Computing for Image Processing

Chris Padwick, DigitalGlobe

High Performance Cloud Computing for Image Processing DigitalGlobe is a commercial satellite imaging company based in Longmont, Colorado. Timeliness of information is very important to DigitalGlobe's customers. Reducing the timeline from image acquisition to image exploitation from hours to minutes is a challenging problem due to the volume of data acquired (more than 3 Terrabytes of new imagery is acquired daily by DigitalGlobe's constellation). DigitalGlobe has built a high performance image processing system (HPIPS) designed to minimize the time required to generate advanced image products. The HPIPS system is scalable across thousands of processors and supports elastic computing platforms like Amazon's EC2 or private cloud solutions. The HPIPS system features a full image processing workflow comprising the following elements: orthorectification (rigorous model and RPC), pan-sharpening, color balancing, tiling, metadata generation, pyramid generation, and mosaicing. The core processing algorithms in HPIPS are fully multi-threaded and can run on a configurable number of CPU cores or can utilize NVIDIA's Tesla GPU architecture. Performance measurements on individual algorithms implemented in HPIPS show a processing speedup ranging from 106X-121X over single threaded CPU versions of the same algorithm. HPIPS has been benchmarked against an existing high performance image processing system running on similar hardware. In end to end testing, HPIPS shows a 14.4X speedup over the existing system, providing greater than an order of magnitude reduction in processing time.

Web Access to Cloud-based World Elevation Data and Services

Peter Becker, Esri

This paper will describe new patterns in web-based data access, with emphasis on global elevation data, from multiple sources and resolutions, including airborne lidar. Traditional web-based access to imagery and rasters has focused on the ability for users to search and then download collections of data to be locally processed. The advent of rapid access to worldwide imagery in consumer mapping web sites has created increased demand for similar simple access to a range of imagery and raster products to be accessed as dynamic services. The increase in server processing capabilities (Infrastructure as a Service) now enables users to access imagery products that are created on-the-fly directly from the source rasters and lidar point clouds. Such services not only provide access to visualization products (e.g. an elevation hillshade), but also enable users and software applications to directly access source data values, in a client-specified resolution, projection, and area of interest. These servers are also being employed to perform more complex tasks on the server (Software as a Service) to ultimately return only the required analysis results to the client application, enabling the creation of focused applications and leveraging the computing power of the cloud. These trends emphasize the concept of "bring the CPU to the Data, vs. the Data to the CPU" for BIG data in the Cloud. The paper and presentation will outline modern approaches to meet these requirements, and typical challenges to be considered.

Cloud - The New Modality for Geospatial: Opportunities, Challenges and Best Practices
Mark Baker, Esri

Cloud computing has gone from a noticeable blip, to an unstoppable trend in technology. Leveraging the benefits of cloud computing services (SaaS, PaaS, and IaaS) is now within reach of the geospatial community from technologists and practitioners to scientists and C-levels. This presentation will address several thought-provoking suggestions for leveraging the opportunities that the cloud may offer you and your organization, but tempering the cloud enthusiasm with realistic key challenges. Additionally, this session will showcase multiple use-cases of geospatial solutions that navigate the cloud to leverage the varied deployment models.

A Fully Scalable Cloud Lidar Distribution System
Shane Engel, Dewberry

Big geospatial data presents challenges in traditional data centers, and the cloud is no different. The Northwest Florida Water Management District embraced the benefits of the cloud and confronted these challenges head on, publishing their entire elevation data holdings on IaaS for public use in a nimble mapping app. We'll show how our process for handling data management and cloud provisioning offers a fully scalable platform to respond to changing demands while saving money on infrastructure.

TS 2- Lidar I – Emerging Trends & the Future

Recent Advances in Lidar Waveform Processing
Amar Nayegandhi, Dewberry

Many commercial airborne LiDAR systems now provide full waveform digitization of the return pulse. Traditional discrete-return LiDAR systems typically record several (up to five) returns for each laser pulse. Full waveform digitization of a laser pulse creates a pulse-by-pulse reflection record that is highly sensitive to even minor changes in vertical structure. This technique enables many multiple returns with short separation to be collected from a single laser shot. This is especially true for a short-temporal-pulse-width laser pulse. The ability to detect separate returns from closely spaced surfaces is relevant for detection of ground returns beneath short-stature vegetation. Further, deriving forest measurements related to volume and canopy structure can benefit from the fine resolution between successive returns from the vegetated canopy. Many commercial systems now provide the option to digitize the return waveform in 1-nanosecond increments. However, the software to process waveforms is lacking and there are no standard formats and guidelines for storing waveform data. In this paper, we discuss waveform processing techniques using a variety of pulse detection methods, such as threshold, center of gravity, maximum, zero crossing of the second derivative, and constant fraction. Gaussian decomposition/deconvolution and adaptive signal processing techniques are also discussed to resolve bare-earth in short wetland environments and shallow bathymetric returns in riverine / coastal environments.

Real-Time Flash Lidar Data Distribution and Processing for Time-Critical 3D Mapping Applications
Dennis Nicks, Ball Aerospace

The use of LiDAR systems for the collection of 3D terrain data is widespread and common for both military and civilian mapping applications. Commercially available scanning lidar systems create large volumes of data that need to be downloaded from the aircraft and post processed. The time latency between data collection and map product distribution can be days to weeks. This is not ideal for missions such as military planning and humanitarian relief where time is critical. Real-time data collection validation and quality assessment also increases efficiency of production mapping activities such as corridor mapping, reducing time on site for commercial mapping companies. The Ball Aerospace Total Sight 3D Flash LiDAR was developed to meet these time critical mapping requirements. The Ball Aerospace Total Sight™ 3D Flash LiDAR continues to evolve and demonstrate the capability to meet these civilian and military low-latency 3D mapping requirements. Recent developments include longer range performance, visible and mid-wave infrared (MWIR) sensor fusion for day/night context imagery, wide field of view mapping performance, special control modes for corridor mapping applications, demonstration of live data broadcast to a simulated tactical operations center (TOC) down-linked from an aircraft, real-time georeferencing and stitching of the down-linked 3D terrain data for ingest into a 3D model viewer (QT Modeler), and real-time distribution of the stitched georeferenced data into other mission tools (Ball Aerospace's Real-Time Situational Awareness, GEODE and Opticks tools). These enhancements were recently field tested in both civilian and simulated military environments. Details of sensor and real-time processing enhancements plus results from recent field testing are presented.

Extending on the MS Kinect Calibration
Charles Toth, The Ohio State University

The Microsoft Kinect sensor is increasingly used in applications outside of the field of videogames. Flash LiDAR and RGB camera make the Kinect an inexpensive yet powerful mapping sensor. To achieve the highest potential of the Kinect sensor, calibration is needed, including the projection system, the ranging and co-registration of the 2D (RGB image) and 3D (Flash LiDAR) imaging sensors. For example, the standard calibration for the last task is based on referencing four points, while the 2D camera is usually calibrated by chess-pattern planar targets. Including more points as well as using the intensity image of 3D sensor, a better co-registration can be obtained. In addition, the object distance dependency, studied in a previous effort, can be factored in. This study aims at optimizing the Kinect calibration processes. Consequently, the better sensor characterization, achieved by improved calibration, should result in higher accuracy data, and thus, increases the value of this simple mapping sensor.

Full Waveform Lidar
James Young, AeroMetric

Full waveform LiDAR has been available commercially for about 7 years now. There is a lot of confusion within the industry as to what it is and how it can be used. The presentation will discuss a brief history of full waveform technology, What it is and how it works, and what technology is used for a LiDAR sensor capable of collecting it. An addition, Full waveform and on-line waveform and the benefits of both will be discussed. The waveform hardware and software used to process waveform data will be presented. Lastly, applications and benefits will be detailed as they relate to waveform information.

TS 3 – Strategies for Multi Sensor Integration

Mobile & Airborne Multi-Sensor Integration for Airport Engineering
Mark Romano, Earth Eye, LLC

Multi-Sensor Integration of mobile and airborne data including development of data products for Little Rock Air Force Base. Discussion of a comprehensive study which includes, evaluation of current airspace obstructions using airborne LiDAR and Imagery, High accuracy surface modeling of the runway using mobile LiDAR, asset mapping and identification utilizing a 360 degree mobile imaging system, and engineering level task that were achieved at the desktop level as a result of this unique approach. This project alleviated extensive ground survey tasks and delivery time lines as a result of this unique approach.

Real-Time Multi Sensor Integration and Analysis in Geospatial Applications
Morakot Pilouk, Esri

Organizations often need to integrate and analyze real-time data from a variety of live sensors such as GPS, RFID, and weather. Utilizing this mission critical information to manage operations and provide situational awareness is frequently challenging to accomplish. This paper presentation will illustrate how this challenge can be addressed. We will introduce real world scenarios that acquire streams of data from multiple type of sensors, analyze the geospatial events immediately as they are received, and disseminates output to a variety of geospatial applications. We will show how modeling of real-time processing tools can be used for in-depth analysis of multi sensor data. Implementation patterns will be presented showing visualization techniques of spatial and temporal data in both 2D and 3D mapping applications.

Rule Based Multi-Sensor Integration in Geospatial Applications
Michael Martin, LSI

Breakthroughs in communication speed and ease brought by the Internet, and decreased cost in computing power and digital storage have brought us to the age of cloud computing, where IT infrastructure, data and applications can be omnipresent: both ubiquitous and centralized. This technological revolution challenges the very premises that dictated the organizational design of the geospatial enterprises in the past decades. By whom, how and where geospatial value is created? The answers to those critical questions are changing and so shall our organizations to truly leverage the power of the cloud. This session is a provocative discussion of what a cloud-based geospatial organization might look in the not-so-distant future. We go over examples of distributed and market oriented organizations in geospatial and non-geospatial realms and the way these new organizations could challenge the current hierarchical organizational models.

Multi-Platform Sensor Networking for Large Scale Natural Disasters
Raad Saleh, U.S. Geological Survey

In this paper, it is argued that combining traditional remote sensing with other systems, such as seismological detectors and ocean wave sensors, would provide an adequate early warning system of large scale natural disasters. Such a system would possibly be adequate to avert the enormous humanitarian, economic and environmental impact a large scale disaster may bring about. The premise is that the integration of ground- and ocean-based sensors, with airborne and space-borne systems, can provide an enhanced capability in comprehensive monitoring, modeling, validation, and early warning. This paper would explain the concept of Multi-Platform Sensing and Sensor Networks, underlying technological issues, operational aspects, and policy issues.

SS 4 – Deepwater Horizon Imagery Location and Access I

Special Panel Session: The Deepwater Horizon 2010 MC252 incident, which occurred April 20, 2010, continues to generate investigation and analysis using GIS and remote sensing imagery for response, natural resource damage assessment, and restoration. Approximately 180 terrabytes of imagery data have been acquired associated with the incident and assessment. There is a growing need for users to locate, view, access, and understand the appropriate use of the spatial data related to the MC252 event. This special panel series features and explains a portal that provides an interface to the three major websites that house the majority of imagery and flight data for the Deepwater Horizon 2010 MC252 event. The portal is a single point for accessing, locating, and maneuvering through the sites that house pre-, during, and post -imagery and data. Four experts from three of the organizations will explain data aquistions and how to access the data for the Deepwater Horizon 2010 Oil Spill: 1) the US Geological Survey's (USGS) Hazards Data Distribution System (HDDS), 2) National Oceanic and Atmospheric Administration's (NOAA) Environmental Response Management Application (ERMA), and 3) British Petroleum's (BP) imagery website.

TS 5 – Oral Poster Presentations

Investigation into Cloud Computing for More Robust Automated Bulk Image Geoprocessing
Richard Brown, Computer Services Corporation

Geospatial resource assessments frequently require timely geospatial data processing that involves large multivariate remote sensing data sets. In particular, for disasters, response requires rapid access to large data volumes, substantial storage space and high performance processing capability. The processing and distribution of this data into usable information products requires a processing pipeline that can efficiently manage the required storage, computing utilities, and data handling requirements. In recent years, with the availability of cloud computing technology, cloud processing platforms have made available a powerful new computing infrastructure resource that can meet this need. To assess the utility of this resource, this project investigates cloud computing platforms for bulk, automated geoprocessing capabilities with respect to data handling and application development requirements. This presentation is of work being conducted by Applied Sciences Program Office at NASA-Stennis Space Center. A prototypical set of image manipulation and transformation processes that incorporate sample Unmanned Airborne System data were developed to create value-added products and tested for implementation on the ”cloud”. This project outlines the steps involved in creating and testing of open source software developed process code on a local prototype platform, and then transitioning this code with associated environment requirements into an analogous, but memory and processor enhanced cloud platform. A data processing cloud was used to store both standard digital camera panchromatic and multi-band image data, which were subsequently subjected to standard image processing functions such as NDVI (Normalized Difference Vegetation Index), NDMI (Normalized Difference Moisture Index), band stacking, reprojection, and other similar type data processes. Cloud infrastructure service providers were evaluated by taking these locally tested processing functions, and then applying them to a given cloud-enabled infrastructure to assesses and compare environment setup options and enabled technologies. This project reviews findings that were observed when cloud platforms were evaluated for bulk geoprocessing capabilities based on data handling and application development requirements.

Modeling Line-of-sight Visibility Below the Canopy With Airborne Lidar Point Cloud Data

Michael Starek, Texas A&M University-Corpus Christi

Small-footprint LiDAR scanning systems have proven their effectiveness in modeling the upper forest canopy and in allowing the extraction of tree parameters such as crown height and diameter. However, the ability to estimate line-of-sight visibility (LOSV) from such systems alone for below-canopy applications is not well-developed, though it may be useful for military planning and search-and-rescue operations. We investigated methods to address the problems of LiDAR pulse undersampling below the canopy and delineation of individual crowns to develop a new estimator of below-canopy LOSV (BC-LOSV). Two forested study sites in north-central Florida were scanned with airborne and near-simultaneous terrestrial LiDAR in order to test a probabilistic model for estimating BC-LOSV solely from airborne LiDAR data. After crown segmentation, allometric projections of the probability model were made into the lower canopy and stem regions to estimate the likelihood of vision-blocking elements present for particular LOSV vectors. Results showed an approximate absolute average difference of 20% between BC-LOSV estimates from the airborne and terrestrial point clouds, demonstrating the utility of a data-driven model for BC-LOSV that is dependent only on small-footprint airborne LiDAR data and physical knowledge of tree phenology.

Applications of Interferometric Synthetic Aperature Radar (IFSAR) at the National Geospatial Techical Operations Center

Kimberly Mantey, U.S. Geological Survey

There are several methodologies for collecting elevation data. Depending on the requirements for a project, the location of the data, and budget constraints some devices are better than others. The National Geospatial Program, supported by the USGS and other groups is currently pursuing a monumental project: updating elevation data for Alaska with medium to high resolution data. Due to the nature of this project, it was determined that an active airborne sensor would be the most appropriate device to collect elevation data. Cost components, length of flying season, and climate conditions in Alaska were all important factors in choosing a sensor. Based on these considerations a platform utilizing Interferometric Synthetic Aperture Radar (IFSAR) was chosen, due to the ability of IFSAR to penetrate cloud cover and canopy with certain wavelengths, its relatively high accuracy, and its affordability. IFSAR is a type of Side-looking-airborne-radar (SLAR), and falls under the category of Synthetic Aperture Radar. SAR devices are unique because of their ability to â€œsynthesizeâ€ antenna length, enabling these scanners to acquire data over very large areas using a relatively small antenna. SAR systems produce radar images, measuring in x and y coordinates. IFSAR is unique because of its ability to measure x, y, and z coordinates. Additionally, IFSAR (like other SAR systems) utilizes multiple radar bands at different wavelengths. This enables the system to penetrate cloud cover, canopy, etc. So far the IFSAR collection in Alaska has utilized x and p band IFSAR, and a combination of the two in certain areas. For the Alaska project, Ortho-rectified radar image (ORI) rasters, digital surface models (DSM rasters), bare earth rasters (DTM rasters), and hydrographic masks (extracted hydrographic features) are collected. These are sent to and reviewed at the USGS, and processed for the National Elevation Dataset.

Lidar and the National Map
Lori Phillips, U.S. Geological Survey

LiDAR has emerged as the preeminent source for elevation data and a host of derivative products. These data sets are potentially useful to the scientific community and are an integral part of the United States Geological Survey's (USGS) data acquisition and delivery programs. However, not all LiDAR data or LiDAR-derived products are created equal and data intended for The National Map needs to meet certain specifications and requirements. The National Elevation Dataset (NED) serves as the elevation layer of The National Map, and provides elevation data for scientific and mapping applications. The NED is a seamless elevation surface produced from a variety data sources. Over the past 15 years, LiDAR technology has matured into a proven mapping tool used for generating bare earth digital elevation models (DEMs) and has become the most common source for new elevation data being incorporated into the NED. The USGS obtains LiDAR-derived DEMs through direct contracting, partnerships with other government agencies, and through donations from other sources. Challenges for incorporating LiDAR-derived DEMs into a consistent national dataset include varying partner requirements and processing anomalies. There has been increasing demand for research using all information generated from LiDAR remote sensing data and not just bare earth DEMs. The USGS Center for LiDAR Information Coordination and Knowledge (CLICK) facilitates data access, user coordination and education of LiDAR remote sensing for scientific needs. Scientists can use LiDAR point data for global change research, hydrologic modeling, resource monitoring, mapping and visualization, and many other applications. This poster depicts different examples of derivative bare earth DEMs and LiDAR point cloud data, and illustrates required characteristics for these data to be incorporated into the NED or CLICK or both.

Detecting Sub-canopy Plant Invasions in Urbanizing Forests Using Lidar
Kunwar Singh, University of North Carolina – Charlotte

Successful management of biological invasions requires landscape-scale information on the spatial distribution and abundance of the invader. Spectral reflectance properties of high-resolution multi-spectral satellite imagery provide detailed and synoptic perspectives on vegetation composition, but have limited ability to detect the structure and composition of forest understory plant species. To address this, we examine the utility of structural and radiometric indices of forest vegetation â€“ derived from LiDAR (Light Detection and Ranging) data â€“ to detect and map the spatial distribution of invasive understory plant species. We map the understory plant Chinese privet (Ligustrum sinense) as a case study of a rapidly spreading exotic species in urbanizing forest landscapes. Our approach uniquely integrates LiDAR-derived indices with field data on forest structure using an ensemble classifier, the Random Forest Algorithm, for detection and mapping of an invasive plant species. We evaluate the hypothesis that the evergreen nature of Chinese privet and its height range from 1 - 5 m provide sufficient structural and radiometric characteristics for LiDAR detection. We discuss the characteristics of Privet (e.g. size and rarity) and presence of other plant species (e.g. confusion with Eastern red cedar) that influence detection and suggest methods for improving invasive species mapping using LiDAR.

A Fast Algorithm for Constructing Spatial Index for Narrow and Long Lidar Point Clouds
Lihong Su, Texas A&M

Lidar surveys on coastal zone, shoreline and transportation corridor usually generate narrow and long Lidar point clouds. An efficient spatial index is necessary for processing the Lidar data. Objective of this paper is to design and implement a fast spatial index for narrow and long Lidar point clouds. Grid spatial index is a simple spatial index. It supports straightforward coordinate computation for its grid cells, which is a desired attribute for efficiently assessing Lidar points. However, simple Grid spatial index is low memory efficient for narrow and long data set because it builds an array of fixed size grid cells over maximum rectangle of geographic extent of a dataset. Lots of grid cells may be empty for narrow and long Lidar point clouds. Conversely, the region quadtree represents a partition of space in two dimensions by decomposing the region into four equal quadrants, subquadrants, and so on with each leaf node containing data corresponding to a specific subregion. However, the tree structure of multiple levels makes coordinate computation of a leaf node region not straightforward. This paper designs an adaptive two-level grid spatial index. The top-level is a conventional grid index with large fixed size grid cell, such as 100 meters, which covers maximum rectangle of geographic extent of a dataset. Each non-empty top-level cell will have a grid index to present a partition of geographic extent of this top-level cell with small fixed size grid cell. This design balances algorithm complexity and space complexity. It can be constructed on-fly due to its quickness. The adaptive Grid index has been implemented by an ArcGIS add-ins and a standalone tool, which is used to support Lidar data operations such as point density, average point ground distances, IDW and Kriging interpolation.

Comparison of Information Extracted from Full-waveform Lidar Data and Conventional Multi-pulse Lidar Data

Hongzhou Wang, University of Houston

A major improvement of LIDAR (Light detection and ranging) is the introduction of full-waveform digitization. With Optech Gemini sensor that capturing multi-pulse data and full-waveform data at the same time, the direct comparison of these two kinds of data is possible. This paper discusses improvements in recording characteristics of objects we could expect from full-waveform data. The evaluation is carried out on two aspects: (1) Comparison of the amount of points in the point cloud generated from the conventional multiple return LIDAR and that from the full-waveform data; (2) How the other information, e.g., intensities and width, could help the further analysis process. The waveform decomposition is carried out using Gaussian decomposition. To avoid slow-convergence and fitting failure, particularly for the saturated ones, Levenberg-Marquardt is chosen for Gaussian parameters estimation. The full-waveform data outperforms conventional scanning data by 8.23% in producing points. This performance of full-waveform LIDAR can be enhanced by using a modified iteration process for Gaussian parameter estimation. First, peak of fitting error is detected, then the location and amplitude of this error peak is used as another group of initial guess of the Gaussian parameters. Thus more points can be generated from the waveform data. On the other hand, full-waveform LIDAR scanning can provide valuable characteristics other than range of the point. Signal width and amplitude estimated by the Gaussian fitting process can offer physical attributes for produced points, therefore give us better classification results.

Application of LIDAR Data for Monitoring Coastal Change in Galveston Island

Xiao Zhang, University of Houston

Extensive alteration of the landform of Texas Coastal zone has created an urgent need to detect changes for disaster emergency response and reservation of coastal habitat. The dynamics of Galveston Island can be quantified and mapped using the high vertical and horizontal point density airborne laser scanners (LiDAR). LiDAR's ability to characterize geomorphic topography of Galveston Island was evaluated, with emphasis on measuring pre- and after- hurricane changes associated with deposition, coastline, vegetation coverage and constructions. Change detection using bare earth models showed that subsidence is not the only reason for elevation loss, but Hurricane Ike has dominated to be a major contributor to the replacement of emergent wetlands by open water and flats, and with the influence of

Oil spill, sea-level rise, and draining/filling of wetlands for residential and commercial purposes, it becomes a difficult recovery after Hurricane Ike. Orthogonal profiles were extracted from LiDAR datasets and plotted out, showing an evident increasing loss of beach elevation close to the shore. Shoreline showed a reduction of more than 1 meter in elevation along the water-sand shoreline and a retreat of over 22 m, which are attributed to beach change during observation interval. In order to avoid effect of topographical change, AGL (Above Ground Level) heights were generated to detect change of vegetation and constructions. Using AGL model, it can be seen that Galveston Island has loss a large amount of vegetation coverage; however from the comparison result, it is evident that people are still building more houses in this area.

High-resolution Imagery to Detect Sediment and Erosion Changes in the Badriver Watershed, WI
Ming-Chih Hung, *Northwest Missouri State University*

Formosat-2 Imagery to Detect Aquatic Invasive Plants along the Ohio River
Ming-Chih Hung, *Northwest Missouri State University*

Evaluating the Ecotourism Potentials of Naharkhoran Area in Gorgan Using Remote Sensing and Geographic Information System
Oladi Ghadikolaei Djafar, *University of Sari*

Feasibility Study on Ecotourism Potential Areas Using Remote Sensing and Geographic Information System
Daraeighadikolaei Naser, *University of Agricultural Science and Natural Resource*

Change Matters in the Cloud
Hua Wei, Esri

Assessment of Fort Riley's Land Condition Recovery Under Multiple Fisturbances Due to Military Training, Burning, and Haying
Santosh Rijal, *Southern Illinois University - Carbondale*

TS 6 – Geospatial Cloud Computing II

UAV based Mapping and 3D Modelling: Image Acquisition and Pix4D Processing Solutions
Christopher Strecha, Pix4D

Cloud Computing and the New Distributed Organization
Antonio Montoya, AeroMetric

Breakthroughs in communication speed and ease brought by the Internet, and decreased cost in computing power and digital storage have brought us to the age of cloud computing, where IT infrastructure, data and applications can be omnipresent: both ubiquitous and centralized. This technological revolution challenges the very premises that dictated the organizational design of the geospatial enterprises in the past decades. By whom, how and where geospatial value is created? The answers to those critical questions are changing and so shall our organizations to truly leverage the power of the cloud. This session is a provocative discussion of what a cloud-based geospatial organization might look in the not-so-distant future. We go over examples of distributed and market oriented organizations in geospatial and non-geospatial realms and the way these new organizations could challenge the current hierarchical organizational models.

Privacy and Security Risks in Cloud Computing
Vivek Ratna, Digital Learning Solutions, LLC

Cloud computing is the latest buzz term in the IT industry that has caused a great deal of confusion. This session is an absolute MUST if you wish to make sense of this new paradigm. Businesses have many choices from which to select technologies and products that all claim to protect data and provide a secure environment. In this session we will first level set with a description of the "Cloud", explore its architecture and then explore the security, compliance and privacy risks. We will pay special attention to why no single element, such as storage, in the stack is not the only device to look at but on how you should focus on a holistic approach to security. If you are among the many businesses that are constantly responding to a barrage of data theft and security breaches then this session will help you navigate through this maze with a â€œpyramidâ€ approach to addressing the broader security and compliance issues. This will include a discussion of new and upcoming standards. Finally, I will share suggestions on how to mitigate, balance or otherwise eliminate the privacy and security risks in cloud computing.

Remote Sensing and Photogrammetry Applications on the Cloud
Joe Mostowy, Intergraph

Explore the challenges and opportunities for Remote Sensing and Photogrammetry applications in SaaS (Software as a Service) and IaaS (Infrastructure as a Service) models. This presentation will evaluate the pros and cons of public, specialized, and private cloud options, including how to charge for the use of software and infrastructure so that it makes economic sense for all stake holders including the software vendor, the cloud provider, and the user. Uncover solutions for working with remote sensing and photogrammetry projects that typically contain data in the gigabyte and terabyte range. Examine a specific photogrammetry example of pixel correlation to generate dense DEMs and a remote sensing example of object-based feature extraction to demonstrate the use of software and infrastructure on the cloud and the kinds of results that are possible. Assess the types of workflows that make sense and others that perhaps are best left on the desktop.

TS 7 – Lidar II – Quality Assessment

PAMAP Program QA Surveys
Eric Orndorff, HRG, Inc.

PAMAP is the base map of the Commonwealth of Pennsylvania. Herbert, Rowland & Grubic Inc. (HRG) was contracted to perform the statewide data collection of checkpoints that were needed to support quality assurance and quality control analysis of both the PAMAP LiDAR data and orthophotography. Due to the multiple data vendors involved in the PAMAP initiative and the varying dates of capture, the "ground truth" testing was essential in guaranteeing a reliably accurate data set. The HRG project team covered a project area consisting of 46,000 square miles in 67 counties in three years, which required the right technology and an innovative approach, to collect 1,400 checkpoints. The accuracy of all checkpoint surveying required the use of dual-frequency GPS equipment. Time constraints and the high volume of checkpoints over an expansive, statewide project area, ruled out the use of static GPS due to the lengthy observation times required. RTK GPS was also impractical due to the large geographic area of the project. This paper will describe the approach and results of a method that rapidly and cost-effectively collected the high volume of checkpoints required over the expansive area.

Quality Control Analysis of Lidar Feature Extraction
Mark Rahmes, Harris Corporation

We present an automated method for quality control of features extracted from several land cover scenes from commercial LiDAR data. Feature Extraction is an important aspect of geospatial management. We discuss the functionality of FeatureSCOPETM which provides an efficient tool for feature analysis and quality control of these extracted features using LiteSite™. Geospatial Foundation Databases must be current for a large volume of high resolution imagery sources. Our algorithms automatically extract features accurately and synchronize or conflate extracted shapefiles from those found with other overlapping images or vector databases. This allows for evaluation of extracted features. Targeted features are extracted by individual feature classes. Accelerated review of features is accomplished up to 100 times faster with the use of FeatureSCOPETM. This technology greatly reduces manual editing while being cost effective for large scale global vector feature data maintenance. Qualitative analysis is accomplished by 2D and 3D visualization. Quantitative analyses are provided using confusion matrices and Receiver Operating Characteristics (ROC) curves to show Probability of Detection and False Alarm of features. Review of qualitative results and cost reduction is shown by using efficient parallel quality control review capability.

Monitoring Vegetation Encroachment on Power Line Right-of-way Corridors using Lidar Data with E3De and ArcGIS
David Gonzalez, Exelis Visual Information Solutions

Vegetation encroachment on power lines is a safety concern and can cause service interruptions requiring expensive, emergency repairs. Because monitoring vegetation encroachment on power lines is labor intensive, it's often neglected and subsequent problems typically arise with little to no warning. Cities and municipalities can now utilize LiDAR data, an increasingly available data type that give users extremely accurate 3D representations of buildings, trees, power lines, and other structures, to effectively monitor vegetation encroachment on power lines without a large commitment of labor hours. This paper will indentify how LiDAR data can be used for vegetation encroachment issues in power line right of ways. In this study, the E3De LiDAR processing and analysis tool was used to extract 3-D features including power poles, power lines and trees. The exported shapefiles were then imported into Esri's ArcScene application to perform the final vegetation encroachment analysis. The resulting analysis highlights the trees that are encroaching on the safety zone, and will need to be trimmed or removed.

Poles Extraction from Mobile Terrestrial Lidar Point Cloud
Sherif Ibrahim, University of Calgary

Mobile terrestrial laser scanners (MTLS) produce huge 3D point clouds that describe a very highly detailed road scene, from which different objects can be generated. The market is seeing a rapid growth in the utilization of these systems in many road corridor applications. These systems are fast and accurate but their use is still limited due to their cost and the huge amount of data they capture.

Extracting different road furniture like poles from MTLS point clouds are important for many applications such as right-of-way asset inventory and GIS applications. The aim of this research is to automatically extract the road poles from an unorganized 3D point cloud of a road scene captured by a vehicle-based laser scanning system named TITAN. The proposed pipeline for the pole extraction consists of a sequence of five steps: organizing the 3D point cloud, nearest neighbour search and morphological analysis to segment the non-ground objects from the input point cloud; 2D density-based segmentation to extract vertical objects from the non-ground segment; vertical region growing to isolate upright objects like poles from the extracted 2D dense objects ; centroid-based 2D distance analysis to merge different segments which belong to the same object; poles extraction from the detected vertical objects based on the height, the surface normal direction and the normalized eigenvalues. Two mobile laser scanning datasets of different scenes are tested with the proposed pipeline. They have different point cloud densities on the street floor, different road side objects like bushes and building facades. These varieties allow testing the performance of the poles extraction methodology. The results of the extracted poles are evaluated based on a reference ground truth data. The obtained detection rates for both datasets are 94% and 96.5% respectively. The extraction results have been quite promising in terms of utilizing only the 3D coordinates of the point cloud as an input.

TS 8 – Data Fusion/Integration in Geospatial Applications I

Accuracy Assessment of Merged Optical, Quad-polarization Radar, Radar texture, and Principal Component Imagery for Land Cover Classification

M. Gregory Hammann, Goerge Mason University

The increasing availability of quad-polarization spaceborne radar provides new opportunities for the remote sensing community. Historically, most spaceborne radars were single frequencies and single polarization. Recently, the PALSAR and RADARSAT-2 systems collect quad-polarization data. Previous studies reported that merging radar imagery with optical imagery can increase accuracy for land cover classification. Using measures of radar texture in addition to the original radar values may also contribute to increased accuracy for land cover classification. In addition, the Principal Component Analysis (PCA) has been used to de-correlate the bands and better separate the signal in the data. The purpose of this study was to examine merged imagery, and compare classification accuracies using ASTER optical imagery, spaceborne L (PALSAR) and C (RADARSAT-2) band quad-polarization radar data, derived radar texture, and PCA measures for a study site in Sudan. For this analysis, a data stack multisource bands was created using band data from the three satellites, and from the derived texture and PCA bands. The variance measure of texture was used and calculated at an 11 by 11 window size for each RADARSAT-2 and PALSAR band. Supervised classification was done using different band combinations for six land covers classes: water, bare ground, sparse forest, active agriculture, fallow, and urban. The overall classification accuracy using the ASTER optical bands alone was 72.2%. The combination of original radar, radar texture and optical data improved classification accuracy to 92.0%. No combination of the radar or radar texture bands without any optical component improved the accuracy compared to optical alone. The L-band PALSAR data improved classification better than the C-band RADARSAT-2 data. The addition of a single cross-polarization PALSAR band increased the accuracy beyond what was achieved using the like-polarization bands, demonstrating the importance of the

Improving Regional Wetland Mapping for the State of Washington
Lisa Erickson, Photo Science, Inc.

Nationwide maps such as the Coastal Change Analysis Program (C-CAP) and the National Land Cover Dataset (NLCD) provide a good picture of regional land cover at a statewide scale. A key component of these maps are wetlands, which are tremendously critical for their ecosystem services and benefits, yet tend be more difficult to map using spectral information alone. Spectrally these features may be very similar to upland vegetation so contextual and ancillary data, such as soil moisture regimes and landscape position, are required as part of the analysis. Supported through an EPA grant, the Department of Ecology contracted NOAA Coastal Services Center and Photo Science to undertake a project to create an improved wetland classification for the 2006 C-CAP dataset for the State of Washington. The process undertaken used Landsat imagery, National Wetland Inventory (NWI), elevation data, soils data and high resolution NAIP imagery to create first a wetland probability map and then use this to improve the wetland classes in the C-CAP 2006 map. The wetland probability map utilized the elevation data through a slope model in combination with hydric soils layers and NWI to identify not just areas of wetlands but also areas that were potentially wet such as wet pastures that could be restored to a wetland function. To support the analysis segmented NAIP imagery was also used to incorporate the higher spatial resolution provided from the aerial imagery. The careful modeling of these data resulted in a wetland probability map that ranged from 0“upland to 10“ water. This dataset was then used in combination with multi-date Landsat imagery to classify the palustrine and estuarine wetlands into aquatic bed, emergent, shrub and forested wetlands. Since this approach uses datasets that are available across most of the US, it is well suited to improving the accuracy of wetland classes in C-CAP and other regional dataset over the whole Nation.

Lidar and Thermal Imagery Data Fusion to Identify Energy Loss
Miranda Lobato, Merrick & Company

Photogrammetric Orientation of the Ultracam Eagle Using Airborne Gps and Imu Read. - Photogrammetric System Calibration
Ricardo Passini, BAE Systems, Inc.

This paper includes a review of all the mathematical models, data reductions and corrections to the observations to be used for a Direct Sensor Orientation through INS/IMU readings and airborne GPS data as applied to the Microsoft UltraCam Eagle. For this purpose, a system calibration is applied through the use of a specially designed boresight calibration test field area that it has been flown at two GSDs (5 and 15 cm, each 90Â° transversal to each other). Each flight was carried out in a forward and reverse direction with simultaneous recording of Airborne GPS and IMU data. 85 signalized Ground Control Points, each one with accuracy (Ïƒo) of 1.5 cm, completing the boresight field. The different steps of the calibration and used mathematical derivations are shown along with the corresponding intermediate results that were statistically checked. Finally, the system calibration parameters are derived and applied to another flight carried out by the same system and the intrinsic quality results checked over existing (and observed) check points in the area.

SS 9 – Deepwater Horizon Imagery Location and Access II

See description above of Deepwater Horizon Imagery Location and Access I

SS 10 – Archeological Use of Lidar

Lidar technology is revolutionizing the science of archaeology by allowing scientists to discern changes in landform and to “see” through vegetation providing a new window into man’s earliest activities. Appling lidar technology to archeology research, ancient cultural resources such as burial grounds and historical settlements can be efficiently mapped and serve as a useful tool to assist archeologists, surveyors and other field staff in modeling where artifacts may reside, streamlining the time and effort expended to manually search for artifacts in the field. This session will provide three case studies of how advanced lidar is being deployed to support archaeological studies of significant ancient sites in Mexico, the Chao Canyon NM and Indian mounds in Missouri. The session will provide valuable insight into topics including project flight planning, project scoping and data deliverables needed to support project missions and the positive impacts the projects have had on the archeology teams.

Archeological use of Lidar to Investigate the Chaco Canyon, NM
Richard Friedman, City of Farmington, New Mexico

Lidar Mapping in Mexico
Bill Emison, Merrick and Company

Lidar Mapping of Indian Mounds in Missouri
Dave Hart, Continental Mapping

TS 11 – Data Fusion/Integration in Geospatial Applications II

Large Scale Asset Inventories Using Mobile Lidar Technology
Eric Andelin

Cost Effective Evaluaton of Change Detection
Patricia Brown, Harris Corporation

We present a software system and process for automated, targeted change detection and analysis, using high resolution commercial satellite imagery, with accelerated review. The design of this system is based on the assumption that the changes that are interesting are distributed irregularly and sparsely throughout an Area of Interest (AOI). This assumption is particularly valid as the feature data update cycles become shorter. In our traditional process, analysts perform pan and zoom operations over a large area searching for targeted features, while flagging and annotating changes. For existing features, where we have a vector database, analysts can use a drive-to type operation, but still must hop around in the AOI to examine each feature. To find new features, nothing short of a full manual roam and search over the imagery is available. Our FeatureSCOPE(TM) process automatically identifies features and areas for examination, and packs up to 100 of these at a time in a condensed view. An analyst can then rapidly page through screens of features and flag and annotate as necessary. The goal is to provide highly accurate updates to the foundation database, while greatly reducing the update time and cost.

Partnerships for High Resolution Land Cover Development in the Lower Columbia River Estuary
Chris Robinson, IM Systems Group

The Lower Columbia River and estuary is a complex ecosystem that supports hundreds of species of animals and is home to hundreds of thousands of people. The Lower Columbia River Estuary Partnership (LCREP) works to protect this nationally significant estuary through ecosystem monitoring, habitat restoration, and educational programs. Up-to-date and detailed land cover data, that accurately characterizes wetland vegetation and other estuarine features, is vital to support these activities. When the Estuary Partnership identified the need for developing such land cover data, they began discussions with NOAA Coastal Services Center's Coastal Change Analysis Program (C-CAP). By partnering with NOAA, they were able to capitalize on C-CAP's experience and national mapping framework. Through this partnership, and the approaches used in this mapping project, LCREP and NOAA were able to produce a high resolution land cover that met both group's needs, within a limited budget. This presentation will detail the integration of high resolution imagery and LiDAR data with image segmentation and object based classification techniques to develop the resulting land cover. The classification scheme, accuracy assessment and challenges encountered during the course of the project will also be covered.

High Spatial Resolution Land Cover, Percent Impervious Surface and Urban Tree Canopy Derived by GEOBIA Techniques for Gainesville, GA
JB Sharma, Institute of Environmental Spatial Analysis

Gainesville is located in Northeast Georgia in the outer suburbs of Atlanta and on the shores of Lake Sidney Lanier, which is the primary source of water for the metropolitan Atlanta area. A 30cm spatial resolution land cover has been derived for the city of Gainesville using four band CIR aerial imagery and LiDAR. This land cover has been derived using Geographic Object Based Image Analysis (GEOBIA) techniques using rule-sets created on eCognition software. This high spatial land cover map of the city of Gainesville provides the basis for several value added products needed by city planners. The percent impervious surface per parcel has been estimated and forms the basis for a storm water utility tax that the cities in the region are considering implementing. The increasing impervious surface in the Lake Lanier watershed is starting to cause increased flooding and stream scour that can be ameliorated by better storm water utility infrastructure and this work provides preliminary estimates of the revenue that can be generated to this end for this study area. The urban tree canopy per parcel and for the entire city has also been estimated and this has implications for water treatment costs. Further modeling applications based on this GEOBIA derived land cover map will also be discussed.

TS – 12 Lidar III – Assessment and Automation

Assessment of Quality of Registration of Overlapping Aerial Lidar Scan
Aparajithan Sampath, SGT

The overlapping regions of an aerial LiDAR point cloud can provide an insight into the quality of data collection, calibration and usability. In this research, three methods will be presented to assess the quality of the registration of the point clouds in the overlapping regions. In recent years, there has been a push to deliver the raw point cloud to the user, apart from tiled datasets and products such as DEM. The raw point cloud data are the only avenues to test the quality of the data, relative to the swaths. This paper builds on recent advances in recent years to provide the users with a method to evaluate the quality of registration of the swaths in the data.

Automatic Selection of Planes in Overlapping Areas for Fast and Reliable Lidar System Calibration
Essam Hamza, University of Calgary

Over the past few years, laser scanning systems (airborne and terrestrial mobile mapping systems) have been established as a leading technology for the acquisition of high density 3D spatial data. The availability of 3D surface data is very important for various industrial, public, and military applications. To ensure the geometric quality of the collected point cloud, the LiDAR systems should undergo a rigorous calibration procedure. The main objective of this paper is to look into current LiDAR system calibration techniques which typically use the manual selection of overlapping areas between LiDAR strips and how to increase the efficiency of these techniques by using automatic selection of regions inside the overlapping areas with different slopes, aspects and distribution which will lead to fast and reliable calibration procedure. The methodology of the proposed technique can be summarized as follows: first, automatic extraction of the overlapping areas between neighboring LiDAR strips ; second, planar patch segmentation is performed over the extracted areas; third, automatic ranking method is applied on the segmented strip pairs to identify suitable areas for the calibration procedure; finally, automatic selection of regions within the selected overlapping strip pairs is carried out. The comparative analysis between manual and automatic selection of regions among neighboring strips is carried out using a rigorous calibration method .The experimental results have shown that the quality of the estimated parameters using the automatic selection are quite comparable to the estimated parameters using the manual selection while the processing time of automatic selection is 3 times faster than the manual selection. These results prove that accurate estimation of the calibration parameters and faster data processing speed can be obtained using the proposed method.

Mapping and Visualization of Mobile Lidar Data
Andrew Fisher, BAE Systems, Inc.

Recent technology advances in mobile LiDAR acquisition and processing software are changing the landscape of surveying and mapping. From its infancy in the mid 90s as a military tool, the technology has grown to be a legitimate player in the commercial surveying and mapping arena. Today, systems are collecting up to 1M points per second. The question is..." How do we use these points". This presentation will briefly review the mobile lidar system and capabilities and demonstrating how SOCET GXP makes it easy to work with the large LAS files to derive highly accurate and quality products. Data visualization and mapping production methods will be discussed using BAE Systems SOCET GXP software.

Introduction to Lidar Data Compression
Jon Skiffington, Lizard Tech

The volume of LiDAR data is growing, as is the amount of storage required to save all of it. A number of technologies and products are now available to compress this data to make it more manageable. In this session, we'll examine the various compression solutions available, their strengths and weaknesses, and what's on the horizon.

TS 13 – Accuracy & Specifications

Best Practices for Lidar Vertical Accuracy Testing
Jennifer Novac, Dewberry

To ensure LiDAR datasets are produced according to specifications and meet end-user requirements, datasets are tested for vertical accuracy. Industry standards for vertical accuracy testing and reporting have been created to help ensure consistency across the industry. In this study, we analyzed 3 methods to verify vertical accuracy and precision: (1) Standard deviation; (2) Root Mean Square Error (RMSEz), and (3) 95th percentile. Our results demonstrated that standard deviation is used to help analyze a dataset to determine precision. RMSEz and the 95th percentile remain the preferred methods for determining vertical accuracy. Vertical accuracy testing performed on the sample dataset showed that standard deviation will not identify large systematic biases in the dataset, whereas RMSEz and the 95th percentile will identify these biases. Vertical accuracy testing performed on these datasets also confirmed the industry standards of using the RMSEz method for open terrain points that follow a normal distribution, and the 95th percentile method for all other land cover categories that may not follow a normal distribution.

Accuracy and Lidar Tracking
Mike Tully, Aerial Services, Inc.

In our new world of volunteered data, public or crowd sourced data, open source data, and web sources of data, GIS professionals and other consumers or users of geospatial data would be wise to slow down and give due consideration to what data are needed and appropriate for use in a given application. There are some basic questions that may be asked about data to be used for a given mapping purpose such as "is there an authoritative source of data for this application?" Certainly once data is discovered it is appropriate to ask questions about the data such as "What is the intended use? What is it's accuracy? Have accuracy and quality characteristics been evaluated? Are the data documented and are metadata available? How did the producers determine or document accuracy, quality, consistency, and content?" Accessing and using data from various sources, of differing scales and resolutions, and with different spatial, temporal, or spectral content may provide a mash up that looks good when casually inspected, but may be fraught with uncertainty and undocumented sources of error and inconsistency. In this session we will explore why "just because it looks good" may not be sufficient reason to use it. Discussions will ensue describing how accuracy considerations and testing need to be applied to LiDAR data processing, testing, and use. This presentation will illustrate methods for LiDAR data which are independent of production solution, unbiased in their approach, and adequate to provide quantitative answers to accuracy and quality criteria that in the past have not been part of verification requirements.

Draft ASPRS Accuracy Standards for Digital Geospatial Data
Dave Maune, Dewberry

The ASPRS Accuracy Standards for Large-Scale Maps, published in 1990, identified the limiting horizontal RMSE (x and y) as a function of the published map scale, and the limiting vertical RMSE (z) as a function of the contour interval. Now that most geospatial products are digital and capable of being depicted at virtually any map scale or contour interval, ASPRS has developed draft Accuracy Standards for Digital Geospatial Products, including LiDAR, digital orthophotos and planimetric data. This presentation will review the new draft Accuracy Standards for Digital Geospatial Data and solicit audience feedback regarding these new potential standards.

Quality Assessment of Elevation Products Derived from Interferometric Synthetic Aperature Radar (IFSAR) at the U.S. Geological Survey National
Kimberly Mantey, U.S. Geological Survey

The National Geospatial Program, supported by the USGS and other agencies is currently pursuing a monumental project: updating elevation data for Alaska using an IFSAR sensor. The IFSAR is flown by independent subcontractors, and elevation data is derived from the raw data products. The data goes through a quality control process at the prime contractor level, and then is sent to the USGS for an independent quality assessment (QA). The National Geospatial Technical Operations Center (NGTOC) review all delivered products of the IFSAR data. The main deliverables currently are Ortho-rectified radar imagery (ORI), Digital Terrain Models (DTM), Digital Surface Models, (DSM), and hydrographic masks. The QA Workflow is broken into three steps. First, the completeness of the delivery is checked, to ensure that all required deliverables were received. During the second round horizontal and vertical accuracies are verified. The final round consists of visual checks of the DTM data. These checks include verification that all artifacts have been removed, that all hydrographic features are flattened, and that monotonicity of the DTM is maintained. The entire process is documented in a QA report, and a recommendation of acceptance or rejection is given based upon the review. If the data is accepted, the project is then sent to the Earth Resources Observation and Science (EROS) Center for further processing and dissemination into the National Elevation Dataset. If the project is not accepted, the USGS provides reported errors to the primary contractor and the process is repeated until the data is acceptable. It is the goal of the NGTOC to ensure that the best elevation data possible is provided to the public, and the role of the IFSAR Quality Assurance procedure is to ensure that this is consistently achieved.

SS 15 – Advancements in GEOINT Analytics I

The PLACES Project and Automated Methods for Place Name Conflation
Ashley Holt, National Geospatial-Intelligence Agency

Landsat-based Early Warning System to Detect the Destruction of Villages in Darfur, Sudan
Andrew J. Marx, U.S. Department of State, University of Maryland

Harnessing Big Data and Models to Solve User Geospatial Problems and Challenges Using IDEAS (Intelligent Data and Model Discovery and Access)
Charles Samuels, The SI Organization, Inc. and Shawna Johnson, Global Marketing Insights, Inc.

TS 16 – Data Fusion/Integration in Geospatial Applications III

Uncertainty Handling in Geospatial Data
Peter Doucette, National Geospatial-Intelligence Agency

The topic of data uncertainty handling cuts across virtually all disciplines. Yet, dealing with uncertainty can induce a certain level of anxiety among data users, which in turn can cause its adequate treatment to be downplayed or avoided. This may be due in part to the perception that modeling and estimating uncertainty can be particularly daunting for some types of data. Nevertheless, a rigorous accounting of uncertainty is often crucial to the decision-making process. For example, the potential impact from the propagation of error, the reliability of a confidence region, or the lack of data provenance can make the difference in selecting a course of action; uncertainty matters! This presentation will address some of the fundamental challenges of uncertainty handling in geospatial data such as (1) promoting the use and efficient visualization of uncertainty metrics; (2) exploiting uncertainty information in geopositioning, mensuration, registration and conflation, fusion, and computational human geography applications; (3) extending the use of standard error metrics when integrating heterogeneous data types; (4) developing new standards for uncertainty that can address a broader set of needs for commonly used geospatial processes; and (5) promoting standards for data provenance that can better enable uncertainty handling.

Change Matters in the Cloud
Jeff Liedtke, Esri

ArcGIS Landsat services provide fast access to the Landsat GLS data with the on-the-fly processing being applied to the imagery as they are accessed. This paper will provide details of improvements that have been made since the original release of these services in March 2011. The paper will detail how different radiometric enhancements are applied dynamically so as to improve use of the services for both analytical and visual access to the data to identify types of change on a regional or global basis. Visual improvements include color balancing as well as stripe removal.

Potential of SAR Interferometry in Detection of Mass Movements in South Kyrgyzstan
Kanayim Teshebaeva, GFZ German Research Center for Geosciences

This study describes the results of potential use of ALOS satellite data for monitoring of the mass movements in Southern Kyrgyzstan, Central Asia. Kyrgyzstan lies within the Tien Shan, an actively deforming and seismogenic mountain belt due to India-Eurasia collision. The mass movement disasters occur almost every year in Southern Kyrgyzstan and causes human fatalities. In this study, I applied SAR interferometry techniques to understand spatio-temporal characteristics of surface changes. The achieved results show a good coherence on high topography over the analyzed period between March 2007 and August 2010. It was possible to derive fringe patterns in the area of landslide prone slopes which can be interpreted as creeping movements indicating reactivation of existing landslides. Our study aims to add information on slope instability using InSAR derived inputs that will support further landslide susceptibility assessment and disaster risk management in this region.

Robust 3-D Change Detections in EO/IR Aerial Imagery
Vishal Jain, Vision Systems, Inc.

TS 17 – Lidar IV – Quality Assessment

Lidar QAQC Performed in a Web-Server/Cloud Environment
Bob Ryan, URS Corp.

LiDAR QAQC Performed in a Web-Sever/Cloud Environment to Streamline Data Through-put and Dissemination. The LiDAR collection process primarily consists of three phases: Acquisition &

Processing, QAQC, and Dissemination. While there have been a lot of advancements in the acquisition & processing phase, the other two phases have remained largely static. The existing workflow involves a considerable expenditure of time, effort, and money by sending multiple hard drives of processed LiDAR data to production teams, as well as project stakeholders for quality assessments prior to preparation and submission of final deliverables. The expenditures are the result of not having a logical process flow which causes the workflow to be repeated several times prior to final approval. This presentation will demonstrate web-driven workflow for visual QAQC and dissemination of LiDAR data. The advancements in web servers and web APIs provide a platform that a streamlined and logical workflow can be built upon. Web tools will be demonstrated for LiDAR data viewing and analysis. LiDAR data can be viewed as TINS, hillshades, and intensity images, while analysis capability is provided by on-the-fly classification and profiling tools for performing quick analysis of data anomalies. All this combined with the ability to "mash-up" with imagery services to provide the visual context that is often needed, allows for a significant advancement in the workflow that mitigates the time wasted on writing, shipping, and downloading data to and from multiple drives, multiple times. For large projects, this solution proves to be very time and cost effective.

Quality Assessment (QA) of Lidar at the USGS National Geospatial Technical Operations Center (NGTOC)
Leslie Lansbery, U.S. Geological Survey

Airborne Light Detection and Ranging (LiDAR) is an active laser scanner that has become a preferred method for measuring the elevation of the earth surface and is responsible for most of the currently available high-resolution digital elevation models (DEMs). The National Geospatial Technical Operation Center (NGTOC), under the leadership of the National Geospatial Program (NGP), provides the review and approval of LiDAR and other high-resolution elevation datasets that will be used to update the USGS National Elevation Dataset (NED). The Elevation Unit of the NGTOC, both in Rolla, Missouri and Denver, Colorado assess the elevation data derived from LiDAR through a Quality Assessment (QA) process. This workflow process involves a complete review of all deliverables received at the Center which entails a visual inspection of the derived bare-earth layer, the presence of complete metadata and verification of LiDAR swath files, LAS classifications and vertical accuracy. A project QA report is compiled during the review and can carry a recommendation of acceptance or rejection based on the outcome of the review. Results that are accepted are sent to the Earth Resources Observation and Science (EROS) Center for integration into the NED and the Center for LIDAR Information Coordination and Knowledge (CLICK). If a delivery does not meet required specifications, data are submitted to the data originator for correction. Upon correction, the data are re-reviewed to ensure that they are ready for integration into the NED. The NGTOC LiDAR QA process is constantly evolving to ensure quality data is provided for the public.

Base Stations: Are They Still Needed to Optimize Lidar Accuracy
Chris Guy, AeroMetric

As we look to improve LiDAR processing in a fast paced, growingmarket, new data collection and processing techniques are constantly being tested and evaluated. The intent is to improve throughput while maintaining quality and accuracy. A main contributor to LiDAR accuracy is the prudent use of base stations to support airborne acquisition. The decision of when and how to utilize base stations can impact projects both in acquisition costs and processing time. Precise Point Positioning (PPP) methods can eliminate the use of ground base stations for airborne acquisition. This presentation will investigate, compare, and present resultant accuracy of airborne LiDAR data sets utilizing PrecisePoint

Positioning (PPP) methods and compare the throughput times and accuracies to solutions generated using basestations.

New Methods of Shallow Water Mapping
Vladimir Kadatskiy, REIGL USA

New Methods of Shallow Water Mapping Historically, shallow water costal mapping was difficult to survey. Conventional methods such as sonar and high power bathymetric LiDAR were ineffective in shallow water while usage of RTK provided low data resolution and required a lot of acquisition time. Breakthroughs in the surveying and mapping technology have enabled new and effective ways of shallow water costal mapping. Recently, RIEGL conducted a demo of the new, state of the art VQ-820-G bathymetric LiDAR in South Florida which demonstrated a fast, efficient, and safe way to collect shallow water bathymetric and topographic data. VQ820-G is a compact, rugged, and lightweight LiDAR unit which offers topographic and bathymetric data acquisition simultaneously from an airborne platform. Other features of the VQ 820-G such as calibrated amplitude and reflectance measurement, high data rate of up to 200,000 measurements per second, full waveform data acquisition with multiple target capability, provide revolutionary methods for shallow water surveying.

TS 18 – Emergency Response

NOAAs Capabilities for Image Delivery During an Emergency Response
Michael Aslaksen, NOAA

NOAA's National Geodetic Survey supports homeland security and emergency response geospatial requirements by acquiring and rapidly disseminating spatially-referenced remote sensing datasets. Primarily digital aerial imagery is captured immediately following an event and quickly provided to aid emergency managers in developing recovery strategies, to assess damage by comparing pre and post event imagery and to allow displaced residents to see images of their neighborhoods and homes. In recent years free and open source tools have become an integral part of the emergency response geo-spatial workflow at NOAA. Python and Quantum GIS are used to manage the project as a whole. OSSIM provides flexible ortho-rectification capabilities while OpenLayers and GeoExt offer easily customizable tools for data dissemination via the web. This session will discuss the tools used by NOAA to acquire, process and disseminate high resolution geo-referenced imagery.

Extending the Operational Envelope of Aerial Electro-optical Imaging Pre-sunrise to Post-sunset for Improved Emergency Response
Robert Ryan, Innovative Imaging & Research

Most emergency response teams heavily use high spatial resolution electro-optical true color, color infrared and panchromatic imagery taken by digital sensors mounted on airplanes or satellites. While the ability to task and field such systems has grown tremendously in the last decade, these systems tend to acquire data only during daylight and good weather conditions due to sensor limitations. Emergency response agencies however, need all weather, day and night imagery and even though RADAR, LiDAR and thermal infrared imaging systems can provide improved data acquisition opportunities, high resolution electro-optical imagery is still preferred for many problems. Although framing digital camera silicon sensors are far more sensitive than film systems concepts of operations have not change much in the last decade since the wide use of digital cameras. Both Bayer array and individually filtered framing camera heads are at least an order of magnitude more sensitive than film opening up potential much lower lit conditions. Large area framing digital multispectral and panchromatic cameras with Time Delay Integration (TDI) capabilities are extremely sensitive could extend the range of traditional imaging systems from pre-sunrise to post-sunset. These systems can already be used for artificial light mapping, which is useful for emergency response and planning. Example imagery for extremely low light conditions, radiative transfer and sensor modeling are shown along with a discussion on how these low lit image acquisitions can support emergency response.

Points in Libya
Connie Li, AeroMetric

I had worked in Libya as a GIS Specialist before their recent war. Working in Libya turned out to be an eye-opening experience which inspired me to share some of my experiences and professional views from my time there. This article will be about my professional and personal experiences in Qadhafi's Libya up until our evacuation resulting from the civil disturbance in February of last year. During the preceding year and a half, I was involved with an American engineering company in many infrastructure and housing projects that had begun with the thawing of relations between Libya and the West in the previous decade. One of the major projects in which I was involved was to work on developing a Geographic Information System (GIS) for the entire country. Though an oil rich country, due to sanctions and lack of professional assistance, Libya had yet to develop much of its infrastructure until this past decade. Moreover, the geospatial industry is almost nonexistent. I will briefly explain the work that was being done throughout the country and focus on some of the technical aspects of the most import projects in developing the country's GIS. I will follow up with some of the benefits and drawbacks of expatriate employment and some of my personal recollections, especially having to leave most personal items behind in a last minute evacuation.

Sharing Spatial Data in the Cloud
Grant Fraley, TerraPan Labs

Geographic information systems (GIS) are becoming the central integration technology for an ever-increasing amount of socially and economically critical information. The need and demand for spatial data has never been stronger or more ubiquitous. Yet, the expansion of GIS faces some fundamental challenges: (1) data storage is currently isolated, localized, and private and (2) data distribution is currently achieved with specialized IT infrastructure, custom development, and either the mailing of disks or bandwidth-intense peer-to-peer file transfer Cloud computing infrastructure holds the potential to overcome these challenges by enabling the scalable storage, sharing, search, monitoring, and manipulation of spatial data in the cloud. A novel platform for the distribution and sharing of spatial data in the cloud is described and the implications of such a platform are explored. The described platform as a service (PaaS) coupled with Amazon's scalable cloud infrastructure provides an always accessible, secure, spatially indexed, and searchable database that will form a universal gateway for spatial data. Such a PaaS is intended to expedite the development of spatial data services, improve access to spatial data, and eliminate capital requirements for spatial data distribution. The efficacy of the spatial data distribution PaaS is illustrated through a description and benchmarking of the data sharing and map visualization service.

SS 19 – Advancements in GEOINT Analytics II

Maritime ISR Data Fusion/Integration for Cost-Effective Improvements in Detection and Monitoring of Illicit Trafficking in Mesoamerican Territorial Waters Implemented Through Comprehensive Engagement Strategy
Thomas D. Morelli and Bradley J. Niesen, Sea Land & Air Technologies & Systems, Inc. (SLATS)

Graphical User Interface for Seagrass Mapping
Hyun Jung Cho, Bethune-Cookman University

Monitoring of Super Algal Blooms in Indian River Lagoon, FL using Satellite Data
Andrew Kamerosky, Bethune-Cookman University

SS 20 – New Frontiers in Lidar Technologies: Geiger Mode Lidar and Full Waveform Digitization

TS 21 – Lidar V, Extraction Techniques

Game Technologies For Enhancing Cloud-based Lidar Utilization
Jason Schwartz, Follow-Me Systems, LLC

Storage and retrieval strategies for Lidar data have gained attention in the recent past as vendors, researchers, and end-users struggle to balance performance with ease-of-use and cost effectiveness. Public cloud storage of Lidar data promises low initial investments and manageable monthly expenses, but may suffer from bottlenecks when the Lidar data are retrieved. Strategies which compress Lidar data for storage in a public cloud only compound the performance bottlenecks by trading processing cycles for storage efficiency. In contrast, local (private) cloud storage demands high infrastructure investments and a monthly power- and support budget; however private-clouds deliver high-bandwidth performance when the Lidar data are accessed on-premise. This paper illustrates a solution to the balancing act of Lidar storage where game technologies are leveraged to radically restructure the problem. The solution relies on techniques for node-based terrain modeling, visual occlusion, and variable level-of-detail (LOD) within game architectures. Remember that these architectures are well known for delivering low cost and high performing geometry for use in real-time rendering across local- and wide-area networks! Because they strike a balance between storage scaling, cost, and performance, game technologies have been adapted to process Lidar data in storage, package it efficiently, and deliver it on the desktop. This paper uses public- private- and local storage / retrieval examples to illustrate the costs, ease-of-use, and performance bottlenecks for Lidar data; the proposed solution is illustrated in similar contexts for comparison purposes. By examining this solution, the audience will better understand the trade-offs available when solving storage cost-performance balance problems. The audience also benefits from exposure to the evolving role of game technologies in solving real-world data challenges.

Segmentation and Reconstruction of Building Facades from 3D Point Cloud

Aparajithan Sampath, SGT

This paper describes a method of segmenting and partially reconstructing building facades from 3D point cloud data collected from a ground based LiDAR. The first step is to create a spatial index of the LiDAR points using a KD-Tree data structure. The points are separated into planar and non-planar regions using a local eigen-value analysis of neighboring points. This is accomplished by conducting an eigen value analysis at each point in the point cloud. A presence of a large eigen-value, and two smaller values indicates a planar (or a smooth) region. The analysis also yields the local normal vector of the surface. Using the normal vector, a virtual plane is constructed at each point, and the intersection point of the normal from the origin to this virtual plane is determined. This intersection point is used as the feature vector in an Isodata based clustering method, which reveals the planar surfaces in the point cloud. The equations of these planar surfaces, given by the normals to these surfaces and their distance from the origin are determined. The segmented points are used to determine the extents of the planar surfaces. This information is used in an adjacency matrix to reconstruct the planar facades of a building. Results of segmentation on data collected on a building using by Topcon and generated using Topcon Scanmaster are shown.

A Method of Meaningfully Reducing LIDAR Data to a TIN Format

Stephan Miller, Harris Corporation

LIDAR data volumes are typically resolved by reducing point clouds to a DEM, today typically at meter or sub-meter GSD. An algorithm for identifying and labelling significant points in the cloud or the DEM allows us to reduce the data volume from LIDAR surveys without significant impact on the accuracy of the data. This ability supports the use of Triangulated Irregular Networks (TIN) as analternative for the representation of the terrain. While the per point data volume still favors the DEM form of representation, meaningul reduction of the number of points makes TINs a viable alternative for most applications.

Palm Biomass Modeling and Archiving Using Terrestrial Lidar

Mwafag Ghanma, UAE University

Palm Biomass Modeling and Archiving Using Terrestrial LiDAR. Palm trees are a primary asset and a source of national pride in GCC countries. With increased interest in breeding better species and wide spreading farming of this tree, medians of local roads and highways are being planted over the years by numerous numbers of trees. The location, age, type, productivity, size, to name a few, of palm trees are all keywords towards assessing the overall value of this national treasure. In an attempt to quantify and map the biomass of palm trees planted within the medians of roads and highways, an efficient and fast method is being sought. LiDAR is increasingly becoming a primary source of geospatial positional data. In fact, LiDAR scanners are now installable virtually on all transportation vehicles. The increased data capture rates of more than 200,000 points per second are leading to unprecedented production rate of spatial data collection. In this research, a mobile mapping platform installed on an SUV with two LiDAR scanners and two digital imaging sensors will be utilized to capture street data and surroundings. Custom created algorithms will be designed and implemented to identify and extract the palm trees, followed by creating a geometric model, labeling, and location tagging for each tree. Subsequent research will focus on identifying the type and other attributes of each tree.

TS 22—Natural Resource Inventory & Assessment

Segmenting the Distribution of Heterogeneous Forested Landscapes: A Size-Constrained Region-Splitting Segmentation Routine

Nathaniel Morton and Brad Weigle, Photo Science, Inc.

The USDA Forest Service tasked Photo Science Inc. to create a mid-level existing vegetation map of the Boise & Payette National Forests (NFs), which updated an outdated 1995 map. Using Very-High Resolution imagery and off-the-shelf software, a Geographic Object-based Image Analysis (GEOBIA) was applied to produce segments on 5 million acres of the forest. Over 18,000 aerial images collected in 2008 from the Digital Mapping Camera (DMC), with1-foot resolution, are the base for this mid-level existing vegetation map. The DMC image mosaic used the most nadir portion of each image to create seamlines for the 5.25m mosaic. eCognition facilitated the automatic delineation of homogenous objects across the varying forested and non-forested landscape scales. Through eCogntion's iterative ruleset design, object primitives became objects of interest through applied expert knowledge using individual DMC bands and DEM layers. Initial objects were produced at larger scale parameters to mimic the TEUI (Terrestrial Ecological Unit Inventory) Forest Service Product. The TEUI-like objects exist nominally at the 5th level hydrologic unit and exhibit criteria that do not cross valley bottoms nor ridgelines, maintain homogeneity within segment, maintain heterogeneity outside of segment, and are within a range for minimum-mapping unit (MMU) size. Additional object smoothing occurred, as well as, small object removal based on NDVI. Further region-splitting of the objects larger than 5 acres were completed through multi-resolution segmentations at iteratively finer scale parameters, until a size-constrained threshold for both upland and riparian objects were met. The final product statistically approached the MMU mean range of two acre riparian objects and five acre upland objects. These objects will be the basis of a consistent and continuous mid-level existing vegetation map product based on a regionally adopted vegetation classification system to aid with Forest Service management.

Evaluation of Forest Conservation Programs: A Case of the Calakmul Man and Biosphere Reserve, Mexico

Jitka Hiscox, Clark University

Our study explores whether the conservation efforts in the southern YucatÃ¡n of Mexico, a 19,000 km2 colonization frontier in the sub-humid neotropics, where the Calakmul Man and Bisophere Reserve was established in 1989 and, in tandem with the MesoAmerican Biological Corridor, maintains the dual goal of protecting local ecosystems and finding sustainable economic alternatives for the local peoples. Based on census data and satellite imagery, this study examines whether the conservation efforts in the 1990s, when community-based conservation programs were active, have resulted in decreased deforestation. Although deforestation in the Calakmul Man and Biosphere Reserve has decreased in the 1990s, after using genetic matching to control for selection bias, the evidence from a regression analysis does not suggest that the conservation programs are correlated with reducing the upland forest loss in the communities they targeted.

Modeling Soil Parameters Using Hyperspectral Image Reflectance in Coastal Wetland Environment

Nicole Hewitt, University of Florida

Previous studies focused on detection of soil moisture through remote sensing. We propose to extend this research to several soil parameters including soil organic matter (SOM), particulate organic matter

(POM), and mineral-associated organic matter (MAOM), as well as various soil components of mineral soil, sand, and silt-clay. According to the Food and Agriculture Organization of the United Nations, SOM is the key to drought-resistant soil and sustained food production. POM and MAOM are both organic components of soil determined by their size. POM can be utilized as an indicator of soil quality, while MAOM functions to stabilize soil dynamics. Soil core samples were obtained from eighteen wetland sites on the west coast of central Florida 1/10th acre plots. Half the sites contain a monoculture of mangrove canopy cover while the other half is comprised of Juncus salt marsh. Atmospheric and geometric corrections were applied to Hyperion image before extracting single pixel spectra corresponding to each field plot. Spectral information was regressed against the soil variables to determine the best single bands and optimal band combinations for the simple ratio (SR) and normalized difference (ND) indices. The results reveal a distinct difference between spectral profiles of mangrove and Juncus plots with higher reflectance from mangrove plots in the 700-1100nm range and higher reflectance from Juncus plots in the 1100-2300nm range. The regression analysis yielded levels of correlation for soil variables with R2 values ranging from 0.27 to 0.53 for best individual band, 0.47 to 0.66 for SR, and 0.45 to 0.62 for ND.

Natural Resource Inventory & Assessment – Communicating the Big Picture, Visualizing and Unlimited Amount of Point Cloud Data Consistently Across Multiple Computing Devices
Bill Emison, Merrick & Company

SS 23 — NGA Academic Partnerships

NGA Academic Research Program
Joan Vallancewhitacre, National Geospatial-Intelligence Agency

NGA 2012 Broad Agency Announcement
Dennis Walker, National Geospatial-Intelligence Agency

Visiting Scientist Program
Laura Locke, Oak Ridge Institute for Science and Education (ORISE)

SS 24 – From Application to Employment: Starting a Career in a Geospatial Discipline

TS 25 – Mobile Mapping

High Accuracy Mapping Using Mobile Lidar, Measurement, Modeling and Entity Creation from Point Clouds
Dave Hart, Continental Mapping Consultants, Inc.

Control Options for Mobile Mapping
Brian Bailey, Surveying Solutions, Inc.

Extraction of Transmission and Distribution Powerline Models from Lidar Data
Ted Knaak, Certainty 3D, LLC

A TopoDOT tool suite for modeling of transmission line models and features will be presented. New tools and processes for efficient extraction of features and 3D models will be demonstrated. Specific capabilities will include: 1) extraction of attachment points for cables, insulators, jumpers, etc., 2) power ground clearance, 3) Identification of tower type and extraction of elevation and radius data, and 4) point cloud classification and identification of encroachment volumes around powerlines.

Mobile Mapping of LAX Airport: Challenges and Solutions
Nikolas Fusco, Photo Science, Inc.

TS 26 – 3D GIS I

Real-Time Visualization with TotalsightTM Flash Lidar
Eric Coppock, Ball Aerospace

Real-Time Visualization with Total Sight™ Flash Lidar. The use of LiDAR systems for the collection of 3D terrain data is widespread and common for both military and civilian mapping applications. The Ball Aerospace Total Sight™ 3D Flash LiDAR supports these kinds of missions, but also enables a different class of capability in the realm of realtime visualization. Total Sight's™ native data format is true color-fused 3D video, and this means that realtime video processing and visualization concepts can be applied directly to 3D data. Figure 1 shows a height-shaded strip of geolocated data; a smear in the image is visible where a vehicle was moving down the road during data collection. The ˜smear" is all you get from a scanned system; post-processing cannot tell you more about the vehicle captured in the data. Flash Lidar, on the other hand, collects inherently video-like frames of data. By looking at the native data format, before or after geolocation, it is possible to extract much more information about the collected scene. Figure 2 shows 1 frame of flash data from the same event. On the left is the 3D color-fused point cloud of that frame, and on the right is the native color context image. Not only is it easy to see that there are in fact two vehicles in the scene, one towing the other on a trailer, but direction and velocity can be measured as well. Ball has invested in the algorithms and realtime processing to demonstrate such realtime capabilities as object extraction, velocimetry, tracking, and hazard detection; these realtime capabilities are made possible by the unique native 3D-video format of Total Sight™ Flash Lidar data.

Beyond Visualization: Enabling 3D Spatial Analysis of Vector Geometry
Tom Watson, LSI

In recent years, the geospatial community has embraced new technologies supporting 3D. However, most existing 3D GI systems are mainly used for visualization purposes such as models, fly throughs, simulations and animations. Systems that are capable of performing 3D spatial analysis on vector geometry provide only a narrow scope of functionality and don't include many of the spatial analysis functions that are common in 2D, such as spatial relations operators, geometric set operators, buffers, and routing. 3D Topology can provide a framework for implementing the missing functionality. Topology fully defines all relationships and interactions between vector geometries that exist. LSI has implemented an ISO 19107 compliant 3D Topology plug-in for Oracle Spatial in order to provide these capabilities. The plug-in includes 1) a 3D Topology Schema for Oracle Spatial, 2) a 3D Topology Builder that structures 3D feature geometries stored in Oracle Spatial database tables and creates the necessary topology in the 3D Topology Schema and 3) an API to interrogate the spatial relationships of the features inherent within the topology. The plug-in allows users to perform analysis such as quality assurance of feature relationships and indoor/outdoor 3D routing.

Create Realistic Perspectives with 3D
Morakot Pilouk, Esri

A 3D perspective creates a realistic simulation of a project, environment, or critical situation to help a variety of clients plan and prepare for and proactively mitigate potential issues. Using 3D requires users to understand and work with large sets of data from multiple viewpoints, have the ability to query a surface, and create a realistic perspective image that drapes raster and vector data over a surface. This presentation will cover strategies for creating, visualizing, editing, analyzing, and sharing geospatial data in three dimensions. We'll discuss How to create 3D scenarios using your existing data. Visualizing your 2D GIS data inside a 3D view to enhance understanding of spatial relationships between objects within an environment. Best practices for managing geospatial data in 3D by editing features and adding 3D components to 2D data using new, robust geoprocessing tools. Analyzing geospatial data in three dimensions to address problems that simply can't be solved in 2D. Easy ways to share your 3D views, animations, and analysis to drive decision making.

A 3D Spatial Model for Surface and Subsurface Spatial Objects
Edward Duncan, 3D GIS Research Group

TS 27 – Sensors and GIS Applications I

Combining Processing Stages for Ultraspectral Image Lossy Compression
Rolando Herrero, Northeastern University

AIRS (Atmospheric Infrared Sounder) images are a type of ultraspectral images that are good candidates to compression as they include several thousand bands that account for well over 40MB of data per single cube. In this paper we present a new architecture to accomplish lossy compression of AIRS images by proposing a sequence of techniques executed under the context of the preprocessing and compression stages. During preprocessing the images are band ordered, spatially segmented and scanned in order to produce a single speech-like signal as output. This signal is then modeled as an AR (autoregressive) process and subjected to linear-prediction while generating LPC (linear prediction coefficients) and error signals that, when encoded, accomplish efficient data compression.

Enhanced Radiometric Performance of Aerial Multispectral Digital Cameras
Mary Pagnutti, Innovative Imaging & Research

Advanced multispectral airborne digital cameras have advanced to the point where their potential radiometric performance approaches or exceeds that of satellite based remote sensing systems. Mosaicing together the large number of frames that is typically needed to cover a region of interest requires excellent image flat fielding and normalization. Color balancing drives the need for excellent band-to-band relative radiometry. In addition, many scientific and quantitative investigations including those that compare data sets from other systems require absolute radiometric calibration. Although many advanced CCD based multispectral cameras are capable of being absolutely radiometric calibrated, the benefits associated with absolutely radiometrically calibrated imaging systems has not been widely exploited by the multispectral aerial remote sensing community. Many of these quantitative scientific studies incorporating vegetation indices, time series analyses, and change detection benefit from atmospheric correction to generate surface reflectance. Surface reflectance without in-situ calibrated targets also requires absolutely radiometrically calibrated data and radiative transfer modeling to perform the atmospheric correction. Additionally, dark scenes of water and dense vegetation require atmospherically corrected data to detect surface variations that can be masked by atmospheric scatter. Consequently absolute radiometric calibration of aerial digital imagery improves the ability of optical data to be fused with digital elevation data to generate new products. This paper discusses optical imaging system parameters, methods and validation techniques required to absolutely radiometrically calibrate multispectral imaging systems. Absolute radiometric calibration of digital aerial multispectral cameras using a NIST traceable integrating sphere and potential fused products will also be discussed.

Addressing the Challenges of Efficient Imagery Acquisition
Timothy Leary, VisionMap LLC

The A3 digital mapping system family was designed by VisionMap to provide the most efficient imagery acquisition available. The capacity of the system to cover thousands of square miles each day, coupled to the efficiency of the automatic processing system, enables projects that were problematic in the past to be successfully completed. Whether covering large metropolitan areas in high resolution, or enabling coverage of states and countries within a season using one or two aircraft, the A3 capaqbilities are unmatched . A myriad applications enabled by the A3 system could pose some challenges. Efficient quality assurance for a wide area may be a bottleneck. If too many controls are required to achieve proper accuracy difficulties could arise. Delivery of the data on hard drives to the end user may require complex IT infrastructure and the end users may be have limited access to data because they need to be off-site, or they may lack the proprietary tools needed to access the data locally. This paper will present solutions for these potential problems. It will discuss in detail how a wide area can be processed quickly, and how the end products may be used with image serves on numerous kinds in order to allow remote, low bandwidth access to the geospatial information by the end users.

An Implementation of Fully-Automated, Real-time Georegistration of Video
Stewart Walker, BAE Systems, LLC

As technology to capture airborne video imagery with metadata for sensor characteristics, position and attitude becomes more capable and accessible, we are challenged with processing the voluminous data fast enough for the resulting information to be useful. There is a growing need for software to georegister the imagery accurately, so that it can be used for intelligence, environmental, transportation and other purposes. Georegistration of video presents unique challenges, however, compared to traditional still image photogrammetry, including qualitative differences such as a smaller field of view, greater range of viewing angles (often above horizon), and fast slewing of turret-mounted sensors, as well as quantitative differences such as much higher frame rate. Many users wish to perform georegistration in real time to keep pace with streaming video. We address several of the challenges in developing an automated video registration capability encompassing real-time, unassisted georegistration to reference imagery and terrain that are selected automatically. The issues addressed include poor quality video imagery and metadata, poor quality reference imagery, and development of statistical estimators to identify erroneous registrations. Results are presented for a wide range of video systems and collection conditions.

SS 28 – 3D Elevation Program (3DEP) and National Enhanced Elevation Assessment (NEEA)

SS 29 – Cloud Data Management

Web Hosting Architectures and Strategies in the Cloud
Pierre Le Roux, AeroMetric

Lidar Data Management in the Cloud
Paul DiGiacobbe, Incubation at HNTB

Distributed Processing in the Cloud
Lewis Graham, GeoCue

TS 30 – 3D GIS II

Using 3D GIS to Sustain the Built Environment
Patrick Wallis, Esri

Buildings account for nine percent of US gross domestic product and almost half the country's greenhouse gas emissions and energy use. The impact of development over the past few decades is clear. With tools to forecast the impacts, markets and consumers would have been better informed regarding more sustainable alternatives. The buildings industry is still significantly based on a paper-driven model, or one with unstructured digital data having no real connection or spatial context to the world at large. One impact is the persistence of erroneous building data within authoritative systems for businesses and cities. Another is the difficulty accessing and integrating it across multiple systems. Buildings and cities are inherently 3D, so the foundation for smarter buildings and cities will not be based on paper, unstructured 2D systems, or even highly structured 3D technologies that are difficult to integrate with other systems. To understand and resolve the challenges facing those managing and living within the urban form, systems providing greater context for individual building objects are critical. GIS is emerging in a new role within the industry for better communication, analysis, and interoperability. It can be exploited to provide key information for decision makers, so they can answer questions regarding the best manner to develop and manage the built environment. GIS enables improvement of the urban form by providing the awareness needed to expose hidden patterns affecting performance, allowing those deficiencies to be corrected; thereby, ensuring its future viability. For example, using 2D, procedural, and BIM derived data to conduct urban growth modeling, zoning change visualization, and view quality/impact assessment. Forecasting the future is a fuzzy science, but one clear step we can take to reverse old and unfavorable trends is to realize that GIS can and should play a key role in managing and sustaining the built environment.

A Web-based 3D Digital Atlas of the Great Smoky Mountains National Park
Chris Strother, University of Georgia CRMS

Airborne LiDAR data, as well as high-resolution orthoimagery for the entire Tennessee portion of the Great Smoky Mountains National Park was acquired in 2011 by the University of Georgia Center for Remote Sensing and Mapping Science (CRMS) and Gainesville State College with funding from the U.S. Geological Survey initiative: The National Map: Imagery and Elevation Maps â€“ American Recovery and Reinvestment Act Program. These data provide a unique opportunity for researchers in the field of cartographic visualization to create detailed and highly accurate three-dimensional (3D) maps and geovisualizations of the landscape. Features of interest to foresters, biologists, hydrologists, arborists, climatologists, hikers, and general tourists such as small streams, vegetation communities, tallest trees, trails and campsites can be represented in an interactive and spatially significant way. Our research identifies the unique challenges that occur with large volume data sets, i.e., Big Data, in a project of this scope, including data storage, processing and web hosting of the final product. We will discuss the development of highly detailed maps of the Park overall, as well as highlighting significant areas of interest to visitors and researchers. This information will be hosted by the UGA-CRMS on the World Wide Web and shared with the National Park Service to demonstrate the value of web access by Park visitors, managers, and policy makes to an interactive 3D digital atlas.

Information Clouds from Aerial Imagery
Belai Besha, North West Geomatics

Modern digital aerial imaging sensors provide multispectral data in very high spatial resolution with wide ground coverage. The interest in dense surface extraction from these sensors, using photogrammetric methods, is rapidly increasing. We have recently presented an implementation for the Leica ADS line-scanner, based on Semi-Global Matching (SGM). This tool has now been extended to process both aerial line-scanner and frame sensor data. The underlying SGM operates at pixel level and, therefore, allows for the derivation of object points at the very resolution of the input imagery. With the spectral bands provided by aerial sensors "typically RGB and near infrared", the derived product can be regarded as an information cloud (info cloud) that combines dense geometry with multispectral radiometry information for each individual point. Both spatial and spectral resolutions exceed those of LiDAR point clouds. Hence, the info cloud suites a broad variety of applications, including but not limited to fields that are currently using LiDAR data. For disciplines such as forestry, the fusion of LiDAR-based ground elevations with tree canopies from info clouds is considered very valuable. Our SGM implementation for ADS has been used extensively in North West Geomatics' production since more than two years, and it has since become part of the Leica XPro ADS ground processing software. The extensions and adaptations to frame imagery will be publicly released shortly. The paper will illustrate our multi-sensor approach and the workflow for info cloud generation. Results from different aerial sensors will be discussed, illustrating the quality and potential of photogrammetrically derived info clouds.

Working with Lidar in a GIS Environment
Cody Benkelman, Esri

GIS systems organize and store information about the world as a collection of 2D and 3D thematic layers. These layers and their associated features can be used to connect natural and constructed environments through a common geographical representation. Lidar has expanded the capabilities of continuously evolving GIS systems by enhancing accurate surface modeling and feature analysis in 3D.

This paper will highlight how GIS users can easily view, analyze, manage, and share large collections of lidar data as point clouds, TINs and rasters. This paper introduces GIS support for lidar data management and analysis workflows. Airborne lidar will be primarily discussed; however support for vehicle lidar data will also be described. This paper also outlines procedures for conducting QA/QC with lidar data, as well as deriving ancillary information and data from airborne and vehicle based lidar. Further topics include editing lidar classification code, sharing and disseminating lidar data, creating features and intensity images from lidar, and editing and updating surface models over time. Finally, best practices and recommendations are provided to ensure optimal use of lidar in a GIS environment.

TS 31 – Sensors and GIS Applications II

Asset Inventory – City of Indianapolis
Eric Andelin, SAM

GIS Applications for Automated Map Production Tailored to Fit User needs for NYC BikeShare
Scott Perkins, T-Kartor USA

Low Land Wetland Mapping Based on SAR and Optical Images
Gang Hong, York University

Wetland plays a critical role in the ecological system through its influence on the carbon storage and sequestration, biodiversity, hydrological condition and water quality and storage, etc. Hudson Bay lowland is the third largest wetland in the world. The Ontario provincial government has committed to conserve and protect those areas due to their significant role in the ecological service.

The difficulties to classify wetland are due to its dynamic hydrological conditions and complex natures since wetland comprises of water, soil and vegetation. A SAR and optical combination has been proposed in the wetland mapping due to complimentary of optical image and Microwave: SAR operates in the microwave portion of the spectrum while the optical sensors in the visible and near-IR spectrum; SAR signal has certain level of penetration while the optical sensor only collects the object surface reflected back information; moreover, SAR backscatter is very sensitive to dielectric properties (soil and vegetation moisture content) and geometric (surface roughness) attributes of the imaged surface. Many methods have been proposed to implement this: the first is to combine SAR images and optical image into a stacked-vector layer and classify them using traditional classification method; the second is to classify the SAR image and optical image individually and combine the classification results together into one single classification result. This paper proposes to use an advanced image fusion method to fuse a SAR image and optical image into one high resolution SAR and optical hybrid image, the SAR image and optical image is combined in an optimum way, i.e., the hybrid image has the spatial details or structural information from the high resolution SAR image, at the same time, it maintains the radiometric integrity from the optical image to the maximum extent as well. The fused image is classified based on the object-based classification technique. The proposed methodology has been tested on Radarsat-2 and Landsat images which are located in Hudson Bay lowland area. The preliminary classification result appears to be very promising.

Fusing Terrain Elevations into Sensor Data
Roger Brown, USACE

SS 32 – Unmanned Aerial Vehicles

Trimble Navigation Becomes a Force in the UAV Market
George Southard, Trimble Navigation

The small Unmanned Aerial Vehicle (UAVs) marketplace is about to undergo some major changes with Trimble Navigation's recent acquisition of Gatewing NV. The use of UAVs in the geospatial workspace has started to grow worldwide. Many new technologies are making it possible for small lightweight UAVs to be equipped with on-board cameras, GPS, IMUs and other devises to collect accurate data for mapping and surveying activities. A number of legal and operational hurdles still exist in the US and many other developed nations. Clearing these hurdles will further open the skies for the use of UAVs in dozens of applications in the geospatial, mapping, agriculture and surveying markets.